Abstract. A synthesis of the majority of the available mare basalt data shows that basalts and glasses came from 28 different volcanic units. The compositions of the magmas of 12 of these units can be calculated with a high degree of confidence. Reasonable estimates can be made for the compositions of nine of the remaining units. In addition, the compositions of three general magma types can be obtained from data derived from the Luna 16, Luna 24, and Apollo 17 fines. The compositional data presented provide a firm basis for the further study of the characteristics of the mare basalt magma source region.

1. Introduction

This paper presents the results of a synthesis of a large part of the data on the compositions and characteristics of the lunar mare basalts available in the literature, data we have stored in the computer based data library. The goals of the study are (1) to identify the number of distinct basalt units present at each mare landing site, (2) to determine which of the basalt samples came from each of these units, and (3) to determine the major oxide and trace element compositions of the parental magmas of these units. The purpose of this program is, thereby, to provide accurate petrological and selenological data needed to further our understanding of the melting mechanisms which produced these magmas and of the composition of the magma source region, i.e., the lunar upper mantle. As such, the results presented here are an extension and considerable expansion of those presented in an earlier paper by one of the authors (Binder, 1976; hereafter referred to as Paper I).

2. Mare Basalt Data

Despite the fact that extremely accurate analytical techniques are employed to obtain selenochemical data on lunar samples, the results presented for any one rock show a relatively large scatter as discussed by a number of investigators (e.g., Mason et al., 1972; Rhodes and Hubbard, 1973; Shih et al., 1975; Paper I). Part of the scatter stems from the fact that the sub-samples (chips, thin sections, etc.) which are analyzed are small and the grain size of the samples is often relatively large. Hence, the individual sub-samples are not necessarily representative of the whole rock from which they came. The dispersion in the rock data due to this type of sampling error has been discussed
and theoretically modelled by Clanton and Fletcher (1976). Reduction of the uncertainties in the composition of individual rocks due to this type of error could, in part, be realized if analyses on several different subsamples of a basalt were available—a requirement which is not generally met for lunar samples.

A more serious source of scatter in the data is due to inter-laboratory biases. Since most of the multiple analyses made on samples were carried out by two or more laboratories, this source of dispersion in the data is most significant. Fortunately, there are several cases where a large number (>20) of rocks (particularly rake samples) have been analyzed in individual laboratories (e.g., Dowty et al., 1973; Warner et al., 1975; Rhodes et al., 1976, 1977; Beaty and Albee, 1978). In such cases, analyses of these internally consistent sets of data can be made independently of each other and of other data sources.

Hence, the available selenochemical data are often quite heterogeneous. As such, the individual basalt units can be identified only when significant trends are observed in the oxide and trace element data and/or when the samples have distinctive petrological characteristics. When the latter are not available, then the identification of a rock as a member of a particular unit is solely dependent on how well it fits the observed trends; hence positive identification is not always possible.

3. Data Library

In order to facilitate the handling and analysis of the large amount of available petrological and selenochemical data, we make use of a computer based data library which stores a large portion (but not yet all) of the available major oxide, trace element, modal, age, etc., data on the mare basalts (and highland rocks). To date, the library contains approximately 70,000 entries on some 214 mare basalts samples.

The compositional data used in our analysis are either the values given when only one analysis for an oxide or element of a sample is available or the average of the given values when more than one analysis is published. However, in those cases where three or more entries are available for a particular component of a basalt, a sub-routine of the library program checks the data, using a standard statistical method, to determine if any of the entries are erroneous. In such cases, the average values are computed from the statistically acceptable data. In this way, the library program rejects from the final averages (but not from the library) any erroneous entries, strongly biased data, or poor sampling results.

Also, a one sigma standard deviation is calculated by a sub-routine in our library program for all oxides and elements for which two or more entries exist. Despite the fact that the computed errors do not have a strict statistical meaning, because of the generally small number of entries, we can at least use the computed errors to indicate the quality and consistency of the data. These errors are propagated through the various calculations we make using the oxide-element data, except for CIPW norm calculations.